THE DIFFERENT MEASURES OF LABOUR PRODUCTIVITY*

An engineer in charge of a workshop or an economist responsible for planning the output of a whole industry at the national level will select the measurement best suited to his objective, i.e. obtaining the maximum output per working hour or allocating the national resources with the greatest economy of means, as the case may be. In the former case, the information needed to take a decision will be based on a measurement of output in physical units (number of components, pounds, yards, etc.) per hour actually worked, and in the latter case on the ratio between the value of the industry's net output and the total number of persons required to achieve it.

Despite all the research carried out and the progress made in standardising output, employment and hours of work statistics,

> "there has been little change in recent years in what might be called the basic methodology or theory of productivity measurement. The alternative concepts that one might plausibly seek to implement, and that may be regarded as valid formal expressions of the term 'productivity', are much the same as those which had become familiar by, say, the mid-forties. The recognised limitations attaching to them are also much the same, though in the last several years they have come perhaps to be better understood and more widely appreciated." 1/

Usually the different methods of measuring labour productivity are classified according to different definitions of output. The two main methods are based on physical and value measurements. There are of course other possible classifications, e.g. by different definitions of input or by level of aggregation. For example, it is possible to make a

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1/ A Brief Survey of Some Methodological and Statistical Considerations by Prof. M. Frankel (Conf.Eur.Stats./WG/21/2), 1964.

classification in accordance with the different measurements used to assess the input of labour to achieve a given output; this would have two main subdivisions, the first based on the labour force (all employees or a specified category of workers, for instance) and the second based on a time unit (the working hour, day or year), which in turn could be related to various categories of workers. This classification, however, would have the drawback of being applicable only to different types of labour productivity and not to the other production factors, whereas a classification based on various forms of output (number of items produced, gross value, net value, volume, etc.) could be used to measure the productivity of factors other than labour.

Different measures of productivity are reviewed below from the standpoint of the two principal methods of measuring output. In the formulas quoted, the labour factor is defined in terms of working hours, but one can equally well choose any other feature to express the input of labour. Even a working hour is not in fact a precise concept. Its duration is clearly defined, but it gives no indication of the quality of the work nor does it tell us whether it was time worked or time paid for. It is worth noting that, while they undoubtedly influence the results, they need not be taken into account in considering the theoretical aspects of productivity measurement.

Physical measures

Physical measures of labour productivity are homogeneous physical units (of weight, volume, area, etc.), used to express an output, usually consisting of a single product or group of similar products, while the labour input is measured in terms of the number of workers or hours worked.

Physical measures are often used to calculate the efficiency of factors other than labour, e.g. bales of cotton per acre to compare agricultural yields, tons of wheat per ton of chemical fertiliser to compare the efficiency of materials, or tons of steel per ton of coal consumed to compare the efficiency of fuels.

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Measurement based on homogeneous physical units

These measurements are obtained by a straightforward computation of the physical units produced - tons of cement, square yards of grey cotton cloth, gallons of beer or pairs of shoes for example - over a given period, usually a year. This total is then divided by the number of units chosen to represent the labour input required to achieve this output, and the result shows the productivity of labour for a given product or group of products.

The formula employed is extremely simple when a comparison has to be made between physical productivity in two periods or countries. One of the results is merely divided by the other:

A1. $$R_{01} = \frac{Q_1}{m_1} \div \frac{Q_0}{m_0} = \frac{Q_1}{Q_0} \div \frac{m_1}{m_0}$$

where Q represents the quantity of units produced, m the manpower input and the figures 1 and 0 two different periods or countries. R_{01} therefore represents the ratio either of the productivity for a single product (or given group of homogeneous products) during the present period to that during the reference period, or of the productivity of one country to that of another.[2/]

The first research into labour productivity was based on this formula, and it continues to be used, especially for purposes of international comparisons, because it involves no problems of weighting or currency conversion.

Homogeneous output

If output is to be regarded as homogeneous, a number of conditions must be fulfilled:

- the product must be of a specified quality, e.g. carbon steel or stainless steel;
- the product must conform to precise standards of size, volume density, etc. (beer with a certain alcoholic content, shoes of a given pattern, for example);

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2/ The formula is often used to compare the productivity of different factories.

- the limits of the manufacturing process must be clearly stated, e g. in the case of cement, it must be made clear whether or not the process includes the mining of limestone.

Defining a product in such a way that differences of quality become immediately apparent is by no means easy and it often happens that items differing in quality are designated by the same name, especially at a time of rapid technological change. This incidentally is a difficulty that has to be overcome in other branches of statistics, especially when price indexes are compiled.

When output is homogeneous, each unit produced is given the same weight, so that it is not necessary to resort to a weighting system. Nor, since homogeneous products are not measured in terms of value, is it necessary to know their cost, and it is possible to compare a homogeneous type of production during two periods or in two different countries without having to calculate "constant" prices or "appropriate" conversion rates. This perhaps explains why physical measurements are so attractive and so widely used in comparing labour productivity as between different undertakings, regions or countries.

However, physical measurements have their limitations in that they can hardly ever be used except in the case of clearly defined products. Once the output becomes heterogeneous, the method is distinctly liable to give misleading results. And the fact is, as Professor Frankel points out, that

> "With allowance for certain exceptions, notably in the mineral extraction and agricultural spheres, not only all industries but most enterprises produce non-homogeneous outputs, in the form of differing qualities of the same product, different types of related or sometimes unrelated products or both".

The Working Group on Productivity Statistics, in the report on its 1964 session, also made a number of reservations regarding the use of "physical" measures in making direct international comparisons. It noted that

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" ... the results of such direct comparisons may not be comparable because of differences in the degree of integration of production in the different countries; for example, in one country component parts may be home-produced, whereas in the other they are imported. The same problem often arises in the case of agriculture (e.g. more or less fertiliser being used in the different countries) and this may be of particular importance when a developed and a developing country are compared." 3/

Heterogeneous output

In some industries, especially steel, brewing, cement, tobacco, footwear and certain branches of textiles (cotton and jute), the output consists of fairly homogeneous products which can be converted into standard units by using conversion ratios. Usually one of the products is selected because it is best suited to serve as a standard and then conversion ratios are worked out for the others. Very often, the ratios employed are based on unit labour requirements. It is not, however, necessary to measure the labour input needed to manufacture each product that has to be converted - usually it is sufficient to know the relationship between this input and that required for the standard product.

In the case of a heterogeneous output in which conversion factors can be used, productivity in two different periods or countries can be compared using the following formula:

A2.

$$R_{01} = \frac{\sum \frac{L_1}{L^*_1} Q_1}{\sum \frac{L_0}{L^*_0} Q_0} \div \frac{\sum Q_1 L_1}{\sum Q_0 L_0}$$

where L denotes unit man-hour requirements for each of the several output items and L* denotes such requirements for the standard product. $\frac{L}{L^*}$ thus specifies the unit man-hours for any item relative to the standard item.

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3/ Report of the Session Held in Geneva, 29 June-3July 1964 (Conf.Eur.Stats./WG/21/5).

"Both the numerator and denominator of the left-hand term involve the weighting of output quantities by relative unit labour requirements, and their division expresses the ratio of the output of /the two periods or/ the two countries in terms of the numeraire product. The right-hand term expresses the ratio between the two countries of the total man-hours expended in the industry, and division of the left by the right-hand term gives simply:

A3. $$R_{..} = \frac{L^{*}_{.}}{L_{.}}$$

which is the ratio between the two countries /or the two periods/ of the unit man-hour requirements for the numeraire product." 4/

All the weights, however, are not based on unit man-hour requirements. In agriculture, for example, output is often converted into food calories, either vegetable or animal; similarly, fodder resources can be compared by working out their calorific equivalents. Fuels, especially coal or gas, can be expressed in energy or thermal units. Other ratios can be calculated from costs or unit prices.

Which conversion ratio is best? The answer must be that the choice depends on circumstances and that the ratios should suit the sectors and countries concerned at a particular time. This amounts to saying that ratios may vary with time and conceal differences between one period or country and another.

Despite the use of conversion ratios, the scope for physical measurement is limited. As differences of quality between the standard product and the other products increase and the items to be converted grow in number, this method becomes more and more difficult to employ.

Measurements based on working time

These measurements have a certain similarity to measurements based on homogeneous physical units whenever the conversion ratios selected are based on standard units of working time. In either case, prices do not have to be taken into account. There is, however, one fundamental difference, namely that when productivity comparisons are being made

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4/ Frankel, op.cit., para. 17.

between two periods or two or more countries, a single series of weights is used. The composition of output is held constant and the aim is to show the difference in the labour time needed to produce a fixed composite of goods or services. The simplest formula is the following:

B1. $$R_{01} = \frac{\Sigma Q_0 L_0}{\Sigma Q_0 L_0} \div \frac{\Sigma Q_1 L_1}{\Sigma Q_0 L_0} = \frac{\Sigma Q_0 L_0}{\Sigma Q_1 L_1}$$

The outcome is equivalent to that obtained when, for output, the quantity relatives of the two countries are weighted by the total man-hours of the base country or period. Thus

B2. $$R_{01} = \frac{\Sigma \left(\frac{Q_1}{Q_0}\right) Q_0 L_0}{\Sigma Q_0 L_0} = \frac{\Sigma Q_1 L_1}{\Sigma Q_0 L_0} = \frac{\Sigma Q_1 L_0}{\Sigma Q_1 L_1}$$

It is equivalent also to the result obtained from weighting the productivity relatives of the several products by the man-hours of the given country or period, as the following shows:

B3. $$R_{01} = \frac{\Sigma \left(\frac{L_0}{L_1}\right) Q_1 L_1}{\Sigma Q_1 L_1} = \frac{\Sigma Q_1 L_0}{\Sigma Q_1 L_1}$$

Professor Frankel, in his paper submitted to the Working Group, discusses the characteristics of this measure:

> "First, for any aggregate like an industry, a sector or the economy, the measure represents an internal average of the productivities of the individual components. If for example the measure relates to an economic sector which in turn is composed of a given number of industries whose output and input quantities and man-hours are the primary ingredients on which the measure is built, the productivity of the sector will always fall within the range of the productivities of the individual industries. ... A second and closely related property of the measure is that it reflects only those changes in productivity that take place within the individual components and abstracts from such changes as might seem to result from a shift of labour from components in which unit man-hour requirements are high to those in which they are low. The effect of such shifts is exactly offset by the application of unit man-hour weights. ... Exclusion from the measure of

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> the effects of structural changes may be regarded as both an advantage and a disadvantage. It is an advantage because it helps us to keep separate the different sources of productivity change and because for certain kinds of economic analysis one has need of a 'pure' measure of this kind. It is a disadvantage because both sources of change are equally constituents in the growth process, and because for many purposes a knowledge of their combined impact, as well as the separate contribution of each, is essential. ... A third noteworthy feature, and one that underlies the other two, is that the composite of goods for which productivity is measured is identical for both countries /or both periods/ measure. .../This/ suggests that the measure is much like a purely physical measure and it sometimes is referred to as such. ... In the case of physical measure, however, 'the quantities entering the measure are those actually produced', while in the unit man-hour measure the constant output composite may be that of the base period or country, the given period or country or a hypothetical composite. It is likely that the result will be affected by the choice of composite, and if, for example, composites differ from one country to another, as they almost invariably will, 'the results in the two cases will generally differ, and each must be accepted as a valid measure of the productivity differences between the two countries.' "

The major drawback of this type of measure lies in the fact that the statistical data needed for it are simply not available in most cases. Depending on the choice of the formulas given above, it is necessary to know the total number of man-hours devoted to each product or component at every stage of the comparison; in addition, it is necessary to have details of the physical quantities produced or of the relationship between the physical quantities or unit man-hours measured at the beginning and end of the comparison. For an industry, economic sector and particularly for the national economy as a whole, it is difficult to obtain all this information. On the other hand, for purposes of comparison between workshops or factories, this type of measure can help to "pinpoint the weak spots in the production process and make it possible to eliminate them and thereby improve productivity" since they permit the calculation of the input of labour required at different stages of the production process for the same product.

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Value measures

We have seen that the economic performance of a whole nation - and of most branches of economic activity - can only be measured by means of an estimate of output value.

> "In the last resort, the true yardstick of the output of a country or a branch of its economy is the value assigned to it by the market. ... Output in other words is not estimated in absolute terms but in relative exchange values reflected in market price relationships. ... Thus, when we measure productivity using a value numerator, we are measuring not a homogeneous entity but a mixture of elements which are interacting on each other. ... The value of output is therefore not the result of productive effort alone. ... The productivity that is measured is not a technical productivity but an economic productivity."

Basic measures

In value measurements, output is evaluated either by means of a price series or by multiplying the physical quantities by a series of value weights. By choosing appropriate prices or value weights, either of the formulas can be made equivalent to the other. In comparing two periods or two or more countries, the basic formula is as follows:

C1.

$$R_{01} = \frac{\Sigma P_0 Q_1}{\Sigma P_0 Q_0} \div \frac{\Sigma m_1}{\Sigma m_0}$$

where P denotes unit price so that PQ is the value of the quantity Q and where the other symbols have the same meanings as before. It is seen that for output the quantities in each country or reference period can be aggregated directly, using the prices of one, or the quantities in one country can first be expressed as a ratio of the corresponding quantities in the other and then extended by value of output weights. This gives the following formula" 5/

C2.

$$R_{01} = \frac{\Sigma \left(\frac{Q_1}{Q_0}\right) P_0 Q_0}{\Sigma P_0 Q_0} \div \frac{\Sigma m_1}{\Sigma m_0}$$

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5/ Frankel, op.cit., paras. 28 and 29.

It is worth recalling at this juncture the distinction between the concepts of "price" and "value". The latter is the aggregate cost of production, i.e. wages and other manpower costs, raw materials and other intermediate items of consumption, depreciation, insurance, rent, interest, etc., together with profits. Price includes not only these factors but also transport and handling costs, discounts, taxes, etc. Prices are affected by supply and demand and also by official regulations which may result in raw materials, finished or semi-finished products and services being sold at more or less than their true cost.

> "A common characteristic of all monetary measurements ... is that they are based on prices of both products and factors of production, and thus will reflect economy in the utilisation of resources only under competitive conditions. These conditions very seldom are obtained in real life and consequently prices are distorted in the sense that they are influenced by market imperfections of various kinds."

This is one of the reasons why value measures are sometimes considered unsatisfactory, because price variations do not necessarily keep step with productivity variations.

The use of a value measurement to compare labour productivity in either time or space implies therefore that allowance must be made for fluctuations in prices or differences in relative prices. For comparisons between one period and another, some countries, such as Poland and the USSR, employ fixed compulsory prices. Other countries prefer to compile price indices for the following reason.

> "/They/ can often be developed on the basis of much more limited data than output indexes. This is so because it is more often reasonable to assume that the price of an industry's products move together than that the quantities move together. A relatively small sample of data may suffice therefore in building a price index whereas it might well be insufficient for building an output index." 6/

On the other hand, it is extremely difficult to ascertain the extent of changes in relative prices, i.e. when the value relationships between commodities change. Some countries, especially the United States, employ

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6/ Frankel, op.cit., para. 29.

the "double deflation technique". Thus, special price indices are constructed for each industry for each component of value added (value of shipments, inventories, etc.). The constant dollar value of each of these components of value added is obtained by deflating the current dollar value of the specified component by its appropriate price index. Value added in constant dollars is then obtained for each industry by deducting the deflated value of material purchases or service costs from the deflated value of output (shipments adjusted for net inventory change). The industry estimates of value added in constant dollars are summed to obtain value added in constant dollars for all manufacturing. The all-manufacturing estimate of value added in current dollars is then divided by the all-manufacturing estimate of value added in constant dollars to obtain the price index for delating manufacturing.

Since the term "output" covers the whole assortment of goods and services actually produced and this assortment is hardly ever the same in any two periods or countries, the result of the comparison is affected by the choice of weight. For example, the weights selected may be applied to either price or value in the reference period or country or in the period or country under investigation. Thus, in Australia in 1953-54 and 1962-63, the GNP per person employed went up by an annual average of 2.4 per cent if 1953-54 prices are used, whereas on the basis of 1959-60 prices the rate of increase was 2.2 per cent; taking manufacturing as a whole, the corresponding figures were 4.7 and 4.3 per cent.

The United Kingdom affords a further example of this. According to a study based on industrial output returns, the index of output in manufacturing between 1948 and 1954 went up by either 4.7 or 2.9 per cent per annum depending on whether 1948 or 1954 prices are used as weights.

The GNP per head in a number of European countries in 1950 and 1955 has been compared with that in the United States. Weighting on the basis of United States prices is more favourable to the European countries than if the comparison is based on domestic prices in each country.

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When the weight is based on value added, it is important to choose the most representative period for which data are available.

Unlike physical measurements, value measurements obtained by means of the formulas mentioned earlier (see C1. and C2.) reflect not only the variations - or differences - in labour productivity in each industry or sector but also the changes - or differences - in the distribution of resources, and above all of manpower.

A number of investigations have been carried out recently into the effect of structural changes on the rates of growth of labour productivity. For example, the Austrian Economic Research Institute has calculated for the period 1951-65 the share of the increase in national productivity considered attributable each year to changes in the pattern of employment. The method was to calculate how far labour productivity would have risen if employment in each of the sectors of the economy had not changed from one period to another; the result was then multiplied by the rate of productivity increase that would have been secured if the labour force during the reference period had had exactly the same productivity as it achieved during the period under consideration. This research showed that, with the exception of 1952, changes in the pattern of employment favoured higher national productivity to an extent ranging from less than 5 to more than 25 per cent, but averaging about 11 per cent.

Research has also been carried out in the Federal Republic of Germany, where comparisons have been made between the changes in labour productivity that have actually occurred in various industries and the results of calculations based on the assumption of a constant distribution of manpower. For the industry sector as a whole - excluding construction - structural changes exercised a negative influence between 1960 and 1964. As in Canada, federal statistics do not contain the data needed to calculate the changes that have occurred in the relative importance of establishments with high and low productivity.

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In his paper for the Working Group in 1964, Professor Frankel describes one of the methods that can be used when making inter-country comparisons in order to distinguish between differences in productivity that exist between different industries and differences in the distribution of resources by economic sector. The method he advocates for making comparisons between two countries can also be adapted for comparisons between two periods. It begins with the formula C1. rewritten as follows:

C3.

$$R_{01} = \frac{\sum P_0 \frac{1}{L_1} m_1}{\sum P_0 \frac{1}{L_0} m_0} \div \frac{\sum m_1}{\sum m_0}$$

In other words, using 0's prices we have, in the numerator and denominator, unit price times (physical) output per man-hour times total man-hours, which gives the total value of the product. One form in which they may be rewritten is

C4.

$$R_{01} = \frac{\sum P_0 \frac{1}{L_1} m_1}{\sum P_0 \frac{1}{L_0} m_0} \times \frac{\sum P_0 \frac{1}{L_1} m_1}{\sum P_0 \frac{1}{L_1} m_0} \div \frac{\sum m_1}{\sum m_0}$$

another form of which is

C5.

$$R_{01} = \frac{\sum \left(\frac{P_0 \frac{1}{L_1}}{P_0 \frac{1}{L_0}} \right) P_0 \frac{1}{L_0} m_0}{\sum P_0 \frac{1}{L_0} m_0} \times \frac{\sum \left(\frac{P_0 \frac{1}{L_1} m_1}{P_0 \frac{1}{L_1} m_0} \right) P_0 \frac{1}{L_1} m_0}{\sum P_0 \frac{1}{L_1} m_0} \div \frac{\sum m_1}{\sum m_0}$$

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"In this manner, the productivity index as given by C1. and C3. is split into two parts. The first, as rendered by the initial term on the right in C4. or C5. reflects only those productivity differences between the individual industries of the two countries. It can be computed, as in C4., by means of a ratio of aggregates in which, for each country, the value of product per worker in the different branches (in country 0's prices) is extended through the use of country 0's man-hour weights. Or it can be computed as an average of relatives (C5.) in which, for each branch, the index of value of product per worker is extended by means of country 0's value of product weights.

"The second part is given by the two remaining right-hand terms which together tell us the difference in productivity arising from the difference between the two countries in the distribution of labour among industries. (In this case value of output per worker in each industry is held constant.) The first of these terms can be computed as a ratio of aggregates (C4.) in which for each country man-hours in each branch are extended by means of value productivity weights. Or it can be computed as an average of relatives (C5.) in which, for each industry, an index of value of product (at constant productivity) is extended by means of value of product weights (based on country 0's prices and man-hours and country 1's productivity). It gives us essentially a measure of the change in output with industry productivity constant." 7/

But - and here Professor Frankel merely confirms the observations of the statisticians in Austria and the Federal Republic of Germany - "there is an element of fiction in this separation process. The two kinds of differences occur jointly in practice and it cannot be assumed that either would be of the magnitude observed without the concurrent presence of the other.'

Measurements based on the gross value of output

Prices and values may be gross or net of certain components. For example, one can choose between market prices or prices at factor cost or one can include or deduct purchased inputs, consumption of output, consumption of fixed capital, direct taxation, etc.

Measurements based on the gross value of output are those in which the numerator itself is the gross value of output, i.e. without any deduction of any kind. The data are usually obtained by adding together the turnover of all the enterprises in the sector in question, making

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7/ Frankel, op.cit., paras. 38-40.

allowance in most cases for variations in stocks of finished and semi-finished products and in work in progress. Some countries, including Bulgaria, Czechoslovakia, Hungary, Poland, Rumania and the USSR, have adopted this method in calculating the output figures or indices on which their labour productivity series are based. Their choice is perhaps due to the ease with which this measurement can be obtained and fitted into the economic planning system and also to the fact that if the trend of productivity were measured by means of net output it would not be substantially different, since the structure of industry and the internal organisation of the enterprises themselves are fairly stable.

There are two drawbacks to the widespread use of gross value measures. The first is that the output does not correspond to the input of labour required to obtain it; the value of the raw materials, fuel, services and other purchased inputs enters into gross value, but their labour content is not taken into account. It follows that once there is a change or difference in the degree of integration or in the proportion of purchased inputs, the productivity comparison between the two periods or countries is distorted.

The second drawback becomes increasingly apparent as production becomes more specialised or the economic sector expands. When this happens, the finished products of one enterprise or industry may pass through several processes before they are finally consumed and as a result are counted more than once in gross output. The extent of the distortion depends ultimately on the way the industry or economy is organised, the degree of specialisation or integration of the enterprises concerned and any changes or differences there may be in the pattern of production.

In short, gross value productivity measurements only yield information - though perfectly valid information - on apparent productivity.

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"What is measured is the result of the whole economic process of production, including activities further up the line from the industry in question. In this way, the performance of the industry embodies transfers of productivity changes to the benefit or detriment of the industry due to variations - in terms of price and quantity - in the pattern of purchases from other industries." 8/

Measurements based on the net value of output

These measurements, as in the previous case, are based on formulas in which the numerator corresponds to a value concept; the value, however, is net value, which is obtained by deducting from the value of gross output that of all the items purchased from other enterprises or supplied by other industries which are consumed in the production process. In other words, the net value represents the contributions made by an enterprise or industry over and above the value of the materials and services it purchases - hence the term "value added". The advantage of this way of measuring output is that the products are only counted once irrespective of the number of times they are bought and sold. The sum total of the contributions by all economic sectors constitutes the gross domestic product - a concept which lends itself particularly well to estimates of national productivity.

Value added can be calculated at market prices (in which case indirect taxes and subsidies are included) or at factor cost (in which case taxes and subsidies are excluded), and the extent to which it is genuinely net varies according to whether certain other items are included or not.

"When isolating an industry in order to measure its productivity ... care must be taken not to make ... double deductions. For example, when input is deducted from output, one deducts the value not only of current purchases (raw materials, power, etc.) but also investment costs (depreciation plus net investment). In this case, in order to obtain the net value added, one must not of course deduct depreciation but one must add net investment to the value added if investment outlays are higher than total depreciation or deduct them if they are lower. If value added minus depreciation is termed 'net', then the 'gross' value added for the industry can be defined as the added value including depreciation. This is not the same thing as the added value obtained by subtracting input from output, which includes neither depreciation nor net investment."

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8/ Frankel, op.cit., paras. 42-45.

In fact we can distinguish between three and not two forms of added value:

1. Value added by the industry (output minus input, i.e. gross output minus (current purchases plus investment outlays)). Fixed capital investment is deducted.
2. Gross value added by the industry (gross output minus current purchases). Fixed capital investment is included.
3. Net value added (gross output minus (current purchases plus depreciation) which is equal to gross output minus (current purchases plus investment outlays plus/minus net investment)).

   Net investment is added to or deducted from the value added by the industry, as the case may be.

   Depreciation is deducted from the gross value added by the industry.

To these could be added a fourth term - "census value added", i.e. that based on information supplied by economic censuses. The most important use made of this concept is in the weighting of the series used to calculate the industrial production indices published by a number of countries. Census value added differs from net value added in that it includes the value of such purchased services as insurance, banking, advertising, legal consultations, etc. These services are therefore included in the value of net output even though they ought not to be. Where census value added is used insetad of other types of value added, it is largely because data for deducting the value of purchased services are not vvailable.

It is possible to attempt a direct measurement of the labour input, even though it is usually impossible to achieve a uniform definition by working out the difference - for each component or branch of activity - between the value of output and the value of all purchased inputs, both at constant prices. The formula for comparing productivity in two periods or two countries is therefore as follows:

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CG. $$R_{01} = \frac{\Sigma P_0 Q_1 - \Sigma \pi_1 \mu_1}{\Sigma P_0 Q_0 - \Sigma \pi_0 \mu_0} \div \frac{\Sigma m_1}{\Sigma m_0}$$

C6.

where P denotes factory or sales prices of products, Q the quantities of products, π the prices of purchased inputs and μ the quantities of purchased inputs.9/

It must be emphasised that this method makes no allowance for consumed output, i.e. the value of the production factors directly consumed in the industry itself, which are not therefore reckoned in the value of net output. The method is also subject to variations in the relative prices of products and production factors. These variations are also the cause of the differences that usually occur in the results obtained by means of weighting indexes, either for the reference period or country or for the period or country under consideration. Lastly, when the value of the output is a residual item, it is extremely sensitive to errors of measurement and the data have to be a good deal more precise than in the case of the other methods.

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9/ Frankel, op.cit., paras. 47-48.